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Enclosure (a)
To LAC/414918

UNPUBLISHED PRELIMINARY DATA

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LOCKHEED-CALIFORNIA COMPANY

BIOPHYSICS RESEARCH DIVISION

(NASA CR 52231

Investigation of the Effects of Ionizing Radiation On the Central Nervous System In Vivo and in Vitro

(CONTRACT NASw-787)

FIRST QUARTERLY PROGRESS REPORT,
For the period of
July 16, 1963 -
to
October 18, 1963

GPO PRICE $ _____

OTS PRICE(S) $ _____

Hard copy (HC) 1.00

Microfiche (MF) .50

[redacted]

Submitted by

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N65 17068 (ACCESSION NUMBER) (THRU)

5 (PAGES) 1 (CODE)

CR 52231 (NASA CR OR TMX OR AD NUMBER) 04 (CATEGORY)

FACILITY FORM 602

Enclosure (a)
to LAC/414918

INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON THE CENTRAL NERVOUS SYSTEM IN VIVO AND IN VITRO

This report is a brief description of research progress during the period July 19, 1963 to October 18, 1963 upon the program:

"Investigation of the Effects of Ionizing Radiation on the Central Nervous System in Vivo and in Vitro."

The period referred to constitutes the first quarter of a twelve month research program pursued under NASA and Lockheed-California Company support, in accordance with Contract No. NASw-787, dated July 19, 1963.

The research has been performed by the Lockheed-California Company, Biophysics Research Division, located at 801 No. Moraga Drive, Los Angeles 49, California; telephone numbers: BRadshaw 2-5550 and GRanite 6-1956. The principal investigators are:

Dr. Eberhardt Sauerland, M.D., and
Dr. Robert Gordee, Microbiologist.

During the period of the first quarter, efficient laboratory arrangements were established and experimentation was begun. For clarity in reporting, the program progress is described in two parts:

Part I: The Effects of Ionizing Radiation on the Central Nervous System of X-Irradiated Cats and Rats.

Part II: The Electrical Characteristics Associated with Neurophysiological Processes of Neurons and Neuroglia in Tissue Culture, and the Subsequent Effects of Ionizing Radiation.

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Parts I and II of the program of research have each been further sub-divided in the description which follows, into: (A) accounts of technological progress, and (B) accounts of experimental program research.

Part I: The Effects of Ionizing Radiation on the Central Nervous System in X-Irradiated Cats and Rats.

A. Technological Progress

The neurophysiology laboratory used in the research is fully operational. A doubly-shielded operating and recording room with a heavy vibration-free table provides a means whereby program experiments can be conducted without electrical or mechanical disturbance from extraneous sources.

Two Grass square-wave tissue stimulators with isolation units, 1 Grass photo-stimulator, 3 Tektronix low level preamplifiers, 2 Tektronix type 360 indicators, 2 Tektronix type 502 dual beam oscilloscopes, 1 Grass model C-4 oscilloscope recording camera, and 1 Mnemotron model "CAT" biological computer were linked together to form a fully synchronized stimulating and recording system.

EEG records are made on a Grass 8-channel EEG-machine, or can be stored on magnetic tape by means of a 4-channel FM-tape-recorder. Furthermore EEG, ECG, DC potentials, and other bioelectrical parameters can be recorded through a Sanborn 8-channel polyrecorder.

All equipment has been carefully calibrated, and system function thoroughly tested in numerous experiments.

B. Experimental Progress

To date, six chronic animals (cats) were operated upon, and proper surgical techniques have been established. Deep bipolar recording and stimulating electrodes were inserted into various areas

of the brain, including the hippocampus, basal forebrain regions, reticular formation, thalamic nuclei, and the amygdala. All leads including those from superficial areas for conventional EEG records were soldered to a sub-miniature connector, and the entire assembly was then permanently attached to the skull of each animal. All cats but one survived, and recuperation was excellent.

Pre-irradiation EEG records were obtained from all animals. In addition, the nature of evoked potentials after auditory clicks and visual stimuli have been studied in two animals with the aid of the "Computer of Average Transients" (CAT).

Two animals received (250 kv) head X-irradiation, the first at a dose level of 4,000 r, the second at 2,000 r. Both animals displayed significant neuropathological symptoms and changes in brain electrical parameters.

At the present time data are being processed, and further chronic electrode implantations and head X-irradiations at lower doses (1,000 r and below) are scheduled.

Part II: The Electrical Characteristics Associated with Neuro-Physiological Processes of Neurons and Neuroglia in Tissue Culture, and the Subsequent Effects of Ionizing Radiation.

A. Technological Progress

The tissue culture laboratory for the preparation and maintenance of explant cultures of the central nervous system is now fully operational. All equipment, including a Wedco roller drum, has been installed, calibrated, and functional performance has been tested.

The experimental arrangement for studying the electrophysiology of neurons and neuroglial cells includes some of the electronic recording equipment described under Part I, A, together with a Leitz Micromanipulator which makes feasible the introduction of

of three microelectrodes into an experimental specimen. Producing and filling glass microelectrodes with tip diameters of less than one micron proceeds on a routine basis in the laboratory work.

B. Experimental Progress

Utilizing the "flying coverslip" method of culturing nervous tissue explants with a medium consisting of 50% Gey's balanced salt solution, 45% inactivated calf serum, and 5% embryo extract (8 day old chicken embryo), and 1,000 units of penicillin per milliliter, outgrowth containing cellular components of the central nervous system has been obtained. Outgrowth of explants of 2 - 3 day old rats prepared from the cerebellum, superior colliculus, and dorsal root ganglia exhibited typical neurons. Neurons have not been demonstrated in the growth of explants from the cerebral cortex. To the present time the cultures of dorsal root ganglia have produced the greatest number of neurons. Outgrowth of explant cultures of white matter including corpus callosum, optic tract, and spinal cord of 10 - 11 day old rats contained cellular elements tentatively identified by phase-contrast microscopy as neuroglia.

Attempts are now in progress to record the resting and action potential of cultured neurons and neuroglial cells.